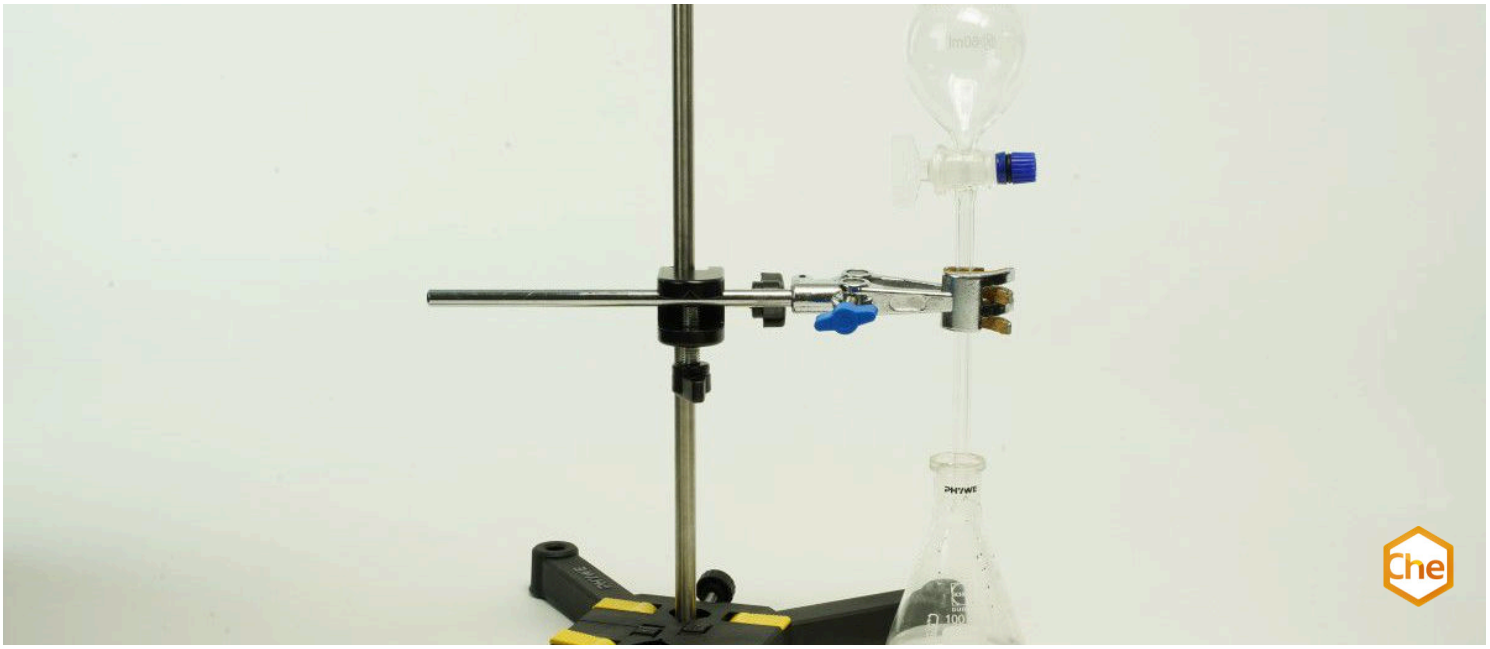
# The acidic character of carboxcyclic (alkane) acids



Chemistry > Organic chemistry > Organic compounds containing oxygen

| Difficulty level | Group size | Preparation time | Execution time |
|---|---|---|---|
| easy | 2 | 10 minutes | 10 minutes |

This content can also be found online at:

http://localhost:1337/c/638b10d9abe2e70003a7e449

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# Teacher information

## Application

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The experimental setup

Alkanoic acids are carboxylic acids and are made up of an alkyl radical and a carboxyl group. They have the general molecular formula $C_nH_{2n+1}COOH$.

In P7172600, formic acid was already presented as the simplest alkanoic acid. In this experiment, the reaction behaviour of formic acid and acetic acid as examples of alkanoic acids is examined in more detail.



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## Other teacher information (1/5)

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**Prior knowledge**

Students should already have a basic knowledge of alkanes and carboxylic acids and the basics of (inorganic) acids and bases. Furthermore, the students should already be familiar with the safe handling of chemicals, as well as butane or Bunsen burners.

**Principle**

Alkanoic acids react with metals to form hydrogen. They are neutralised by alkalis with the formation of salts. Alkanoic acids thus show the same reaction behaviour as inorganic acids.

## Other teacher information (2/5)

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**Learning objective**

The students should learn that alkanoic acids show the same reaction behaviour as inorganic acids.

**Tasks**

Examine formic acid and acetic acid for their reaction behaviour.



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# Other teacher information (3/5)

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## Notes on set-up and procedure

### Preparations

Prepare 10 % formic acid (12 ml of the specified acid to 100 ml water), 10 % acetic acid (11 ml of the specified acid to 100 ml water) and 10 % sodium hydroxide solution (12 g NaOH to 100 ml water).

### Notes on the student experiments

Make sure that the burner is not placed next to the test tubes, otherwise the hydrogen can ignite. The watch glasses must only be heated carefully, as they shatter relatively easily. Bunsen burners can still be used instead of a butane burner.

# Other teacher information (4/5)

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## Notes

Formic acid and acetic acid react with magnesium to form hydrogen, which can be detected by the oxyhydrogen test.

$2\ HCOOH + Mg \rightarrow (HCOO)_2Mg + H_2$
$2\ CH_3COOH + Mg \rightarrow (CH_3COO)_2Mg + H_2$

Both acids are neutralised by sodium hydroxide solution, which is illustrated by the change in colour of the indicator.

$HCOOH + NaOH \rightarrow HCOONa + H_2O$
$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

The neutralisation produces salts that can be recovered by evaporation.



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# Other teacher information (5/5)

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## Methodological remarks

The typical reactions of inorganic acids are assumed to be known. If these have not been dealt with, sulphuric acid or hydrochloric acid can be used in a parallel experiment to show that there is no difference in principle between organic and inorganic acids.

## Disposal

- Allow the magnesium to react completely in the test tubes.
- Put the contents of all vessels into the collection container for acids and alkalis after the reaction is complete.

# Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

For H- and P-phrases please consult the safety data sheet of the respective chemical.

**Dangers**

- Formic acid, acetic acid and caustic soda have a corrosive effect. Put on protective goggles! Wash off splashes on the skin with plenty of water.
- Explosive gas mixtures are formed during the reaction. Do not place burners near the test tubes!



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# Student information

## Motivation

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Diluted acetic acid for food

Alkanoic acids are carboxylic acids and are made up of an alkyl radical and a carboxyl group. They have the general molecular formula $C_nH_{2n+1}COOH$. The simplest alkanoic acid is methanoic acid, which is known by the trivial name formic acid. Acetic acid is also an alkanoic acid. Both acids have an antibacterial effect and are used as preservatives. Acetic acid can usually be found in low concentrations in the kitchen, where it is used as an acidifier. But how do these organic acids behave compared to the inorganic ones?

This experiment investigates the reaction behaviour of alkanoic acids.



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# Tasks

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The experimental setup

Examine formic acid and acetic acid for acid behaviour.



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# Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Support base, variable | 02001-00 | 1 |
| 2 | Support rod, stainless steel, l=370 mm, d=10 mm | 02059-00 | 1 |
| 3 | Boss head | 02043-00 | 1 |
| 4 | Wire gauze with ceramic, 160 x 160 mm | 33287-01 | 1 |
| 5 | Spoon, special steel | 33398-00 | 1 |
| 6 | Watch glass, dia.60 mm | 34570-00 | 2 |
| 7 | Erlenmeyer flask, stopper bed, 100 mlSB 19 | MAU-EK17082002 | 2 |
| 8 | Graduated cylinder, 10 ml, plastic | 36636-00 | 1 |
| 9 | Dropping funnel with drip nozzle, 50ml | 36912-00 | 1 |
| 10 | Test tube, 180x18 mm,100pcs | 37658-10 | 1 |
| 11 | Test tube brush w. wool tip,d20mm | 38762-00 | 1 |
| 12 | Test tube rack for 12 tubes, holes d= 22 mm, wood | 37686-10 | 1 |
| 13 | Ring with boss head, i. d. = 10 cm | 37701-01 | 1 |
| 14 | Universal clamp | 37715-01 | 1 |
| 15 | Protecting glasses, clear glass | 39316-00 | 1 |
| 16 | Pipette with rubber bulb | 64701-00 | 1 |
| 17 | Formic acid 75% 250 ml | 30023-25 | 1 |
| 18 | Magnesium, ribbon, roll, 25 g | 30132-00 | 1 |
| 19 | Sodium hydroxide, pellets, 1000 g | 30157-70 | 1 |
| 20 | Water, distilled 5 l | 31246-81 | 1 |
| 21 | Acetic acid 99...100%, pure 1 l | 31301-70 | 1 |
| 22 | Butane burner with cartridge, 220 g | 32180-00 | 1 |
| 23 | Phenolphthalein, 0,5% soution in ethanol, 100 ml | 31715-10 | 1 |



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## Set-up (1/1)

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Figure 1

**1.** Set up the support base according to Fig. 1.

**2.** Place the dropping funnel in the universal clamp and fill it halfway with 10 % sodium hydroxide solution.

**3.** Place two test tubes in the test tube rack, put a few small pieces of the magnesium ribbon in each.

## Procedure (1/5)

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Figure 2

**1.** Add approx. 5 ml of 10 % formic acid to the first test tube (Fig. 2).



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## Procedure (2/5)

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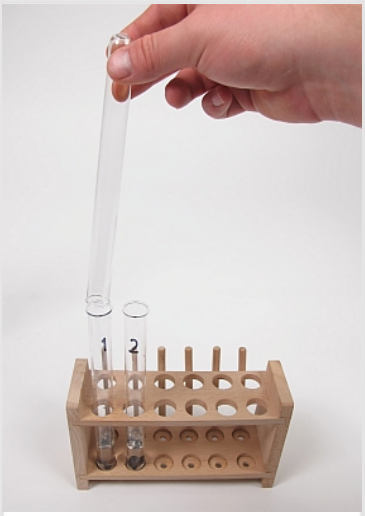


Figure 3

**2.** Place an empty test tube upside down over the mouth of the filled test tube (Fig. 3), perform the oxyhydrogen test with the collected gas.

**3.** Do the same after adding the same amount of acetic acid to the magnesium in the second test tube.

## Procedure (3/5)

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Figure 4

**4.** Put 10 ml formic acid into the Erlenmeyer flask, add a few drops of phenolphthalein solution (Fig. 4) and place it under the outlet of the dropping funnel.

**5.** Open the tap of the dropping funnel so that the sodium hydroxide solution flows in drop by drop (Fig. 5).

**6.** Stop dripping as soon as the colour change remains even after swirling.

Figure 5



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## Procedure (4/5)

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Figure 6

**7.** Change the Erlenmeyer flask, do the same with the same amount of acetic acid.

**8.** Using the pipette, pour a few drops of the solution from the first Erlenmeyer flask onto a watch glass (Fig. 6).

## Procedure (5/5)

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Figure 7

**9.** Heat this carefully over a low flame until the solution on the watch glass has almost evaporated (Fig. 7).

**10.** Do the same with the solution from the second Erlenmeyer flask.

**Disposal**

Allow the magnesium to react completely in the test tubes.

Put the contents of all containers into the collection container for acids and alkalis after the reaction is complete.



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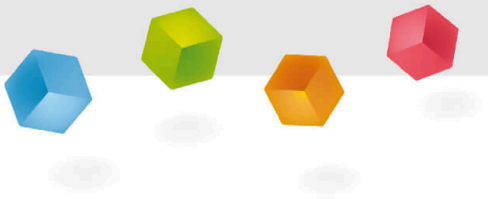

# Report

## Task 1

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**Write down your observations.**



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## Task 2

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Both the formic acid and the acetic acid neutralise by the addition of an alkali with the formation of ... ?

- ○ Metal
- ○ Salt
- ○ Hydrogen
- ○ Sugar

Check

## Task 3

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Which reaction equations are correct?

- ☐ Magnesium + formic acid → magnesium formate + hydrogen
- ☐ Magnesium + acetic acid → magnesium acetate + hydrogen
- ☐ Caustic soda + acetic acid → oxygen + hydrogen

Check

Formic acid and acetic acid as examples of alkanoic acids react with metals to form oxygen.

○ True ○ False

Check



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# Task 4

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## Comparison with inorganic acids

Alkanoic acids and inorganic acids show a

_____

reaction behaviour towards alkalis and metals.

similar | different

Check

| Slide | Score / Total |
|---|---|
| Slide 21: Reaction of acids with alkalis | 0/1 |
| Slide 22: Multiple tasks | 0/3 |
| Slide 23: Comparison with inorganic acids | 0/1 |

**Total** 0 / 5

Solutions | Repeat | Export text



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